Strategic Astrophysics Technology

Demonstration of the Next-Generation Visible Nulling Coronagraph Using a Phase-Occulting Architecture and Segmented Aperture

Completed Technology Project (2015 - 2017)

Project Introduction

Recently, the AURA-commissioned "Beyond JWST" committee presented their recommendation for the next large flagship mission to follow WFIRST-AFTA: a 12-m class segmented UV-Optical-Infrared (UVOIR) telescope capable of detecting and characterizing habitable exoplanets, as well as a wide array of general astrophysics studies. In order to achieve the necessary statistics to provide sufficient confidence in finding a habitable planet, such an observatory would require an internal coronagraph capable of deep contrast at small inner working angle (IWA) over a broad bandwidth that is also compatible with a segmented aperture. Over the past several years, the Goddard Visible Nulling Coronagraph team (VNC) has worked to successfully demonstrate such performance with the lateral-shearing VNC testbed, achieving 5.7x10^-9 contrast at 2 lambda/D with narrowband light and segmented deformable mirror. A broadband demonstration with an actuated hexagonally-segmented primary mirror telescope is currently underway. The present VNC uses two nullers with orthogonal shears to achieve a high order null, and multiple observations with different shears and rolls are necessary to access the full field-of-view. Under two years of TDEM-14 funding, we propose to demonstrate the Next Generation VNC (NG-VNC), which uses phase-occulting (PO) optics that provides full-field, high-order, high-throughput nulling with a single nuller and no observatory rolls. The NG-VNC is an evolution of the existing VNC, and will be the first demonstration of PO optics. We are adopting a performance goal for the NG-VNC that will initially target a contrast of 1x10^-8 at an IWA of 3 lambda/D, over at least a 40 nm bandwidth, with a segmented aperture telescope. Higher contrasts, at smaller IWA over broader bandwidths are expected in follow-on efforts. In addition to the new PO optics, the NG-VNC will include additional upgrades to the existing VNC design: (1) the use of two deformable mirrors (DMs) enabling simultaneous control of misalignment aberrations and polishing defects that give rise to phase and amplitude errors over the entire field-of-view; (2) additive manufacturing techniques that will simplify the alignment effort of the nuller cavity while enhancing stability and robustness through the elimination of mechanical joints; and (3) partnering with Ball Aerospace Technology Center (BATC) to construct a Star-Planet Source (SPS) emulator, consisting of a calibrated pair of sources of known contrast ratio and adjustable separation. Furthermore, as part of this proposed effort, we will partner with the University of Rochester to leverage their expertise in wavefront sensing to develop enhanced broadband sensing and control algorithms for the NG-VNC. At the end of this period of performance we will have demonstrated a coronagraph technology capable of high-throughput observing with a segmented aperture telescope. The NG-VNC provides a path to a TRL-6 flight instrument for a future Large UVOIR mission, such as the Advanced Technology Large Aperture Space Telescope (ATLAST), or the High Definition Space Telescope (HDST).

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Strategic Astrophysics Technology

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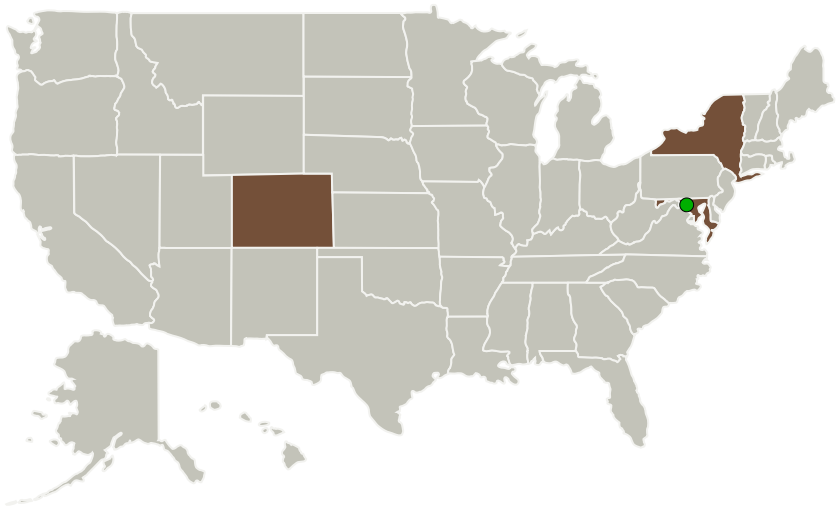
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Colorado	Maryland
New York	

Project Management

Program Director:

Mario R Perez

Program Manager:

Mario R Perez

Principal Investigator:

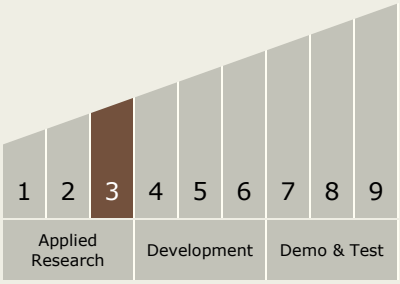
Matthew R Bolcar

Co-Investigators:

John S Knight
Mark Clampin
Richard G Lyon
Peter Petrone
David T Leisawitz
Brian A Hicks
James R Fienup
Daniel S Acton

Technology Maturity (TRL)

Current: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments

Continued on following page.

Technology Areas *(cont.)*

- TX08.1 Remote Sensing Instruments/Sensors
  - TX08.1.3 Optical Components

Target Destination

Outside the Solar System